Influence of the Levels of Soil Contamination on the Early Growth Performance of *Adansonia digitata* Linn. Seedlings

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A B S T R A C T

The indiscriminate discharge of spent engine oil is a major source of soil pollution and the influence of the levels of soil contamination on the early growth and performance of Adansonia digitata was investigated at the forest nursery for the period of twelve weeks. Contaminated and top soil were collected from mechanic garage and Forest Nursery respectively. An headpan was used to measured the contaminated and top soil at gazetteed ratio such as: T1(1:0) Contaminated soil only, T2(1:1) Contaminated soil and top soil, T3 (1:2) Contaminated soil and top soil and T4 (0:1) top soil only. The experimental set up was laid in completely randomization design (CRD) with four treatments and five replicates. Morphological attributes such as shoot height, collar diameter and number of leaves were measured fortnightly for the period of twelve (12) weeks. Inferencial statistics such as Analysis of Variance was employed. The findings revealed that T2 (1:1) contaminated soil and top soil had the best growth vigour in terms of shoot height (4.36 cm) and stem diameter (1.34cm) and its leave mumber followed the best (94.6) and there is significant differences at (p>0.05) level of significance. It can be inferred from the study that Adansonia digitata can be planted at mechanic garages and contaminated soil for cleaning the soil pollution and environment. Further research can be intensified for improvement of the species in terms of economics and ecological benefits it possess.

INTRODUCTION

Adansonia digitata is one of the most important Non-Timber Forest Products (NTFP) providing species with significant ecological and socio-economic significance. It is among the nine global species of baobab in the genus Adansonia from the family Malvaceae and subfamily Bombacaceae (Jen *et al.,* 2016; Salami *et al*., 2018a). Most scientists know the vernacular name of the species as 'baobab' which globally derived it name from the Arabic name "buhibab" meaning fruit with many seeds (Diop *et al.*, 2006; Clayton 2012). The genus name Adansonia is used in nobility of the botanist Michel Adanson (1727–1806), whilst the species name digitata (hand-like) was selected in reference to the shape of the leaves (Döring, 2022). Apart from *Adansonia digitata* which is native to Africa; there is the Australian baobab, *Adansonia gibbosa*, *A. Cunnand* and six other baobab species native to Madagascar namely *Adansonia grandidieri* Baill. *A. madagascariensis* Baill. *A. rubrostipa* Jum and H. Perrier, A. *perrieri capuron, A. suarezensis* H. Perrier. This is the most widespread baobab in Madagascar (Salami *et al.,* 2019). The ninth species that was recently discovered in Africa through morphology, ploidy and molecular phylo genetics research is *Adansonia kilima* Pettigrew *et al.,* (2012). *Adansonia kilima* was found to be superficially similar to *A. digitata* though it could be differentiated on the basis of floral morphology, pollen characters and chromosome number Douie *et al*., (2015).

Adansonia digitata (baobab) is one of the widespread multi-purpose tree species in Southern Africa. It is popularly known as "Africa's upside down tree" due to its structure. Throughout its range, the baobab makes important contribution to people's livelihoods for food, fibre and medicine (Emmy *et al.,* 2010). Baobab trees form a key source of income, especially in the dry season and during times of drought (Sidibe and Williams, 2002). According to Sidibe and Williams (2002), baobabs have an outstanding ability to withstand severe drought and fire, which are two major hazards to plant life in dry areas of Africa. Although baobabs are mostly regarded as fruit-bearing trees, they are multipurpose, widely-used species with medicinal properties, numerous food uses of various plant parts, and bark fibers that are use for a wide range of purposes (Salami *et al.,* 2021; Dhillion and Gustad, 2004; Wickens and Lowe, 2008). Up to 300 uses of the baobab were documented in Benin, Mali, Zimbabwe, Cameroon, the Central African Republic, Kenya, Malawi, South Africa and Senegal across eleven ethnic groups and four agro-ecological zones (Salami *et al.,* 2021; Buchmann *et al.,* 2010). The fruits and leaves are harvested and stored for consumption throughout the year (Buchmann *et al.,* 2010). Fruit harvesting of baobabs normally starts from April to May in Southern Africa and from October to November in West Africa (Sidibe and Williams, 2002). However, there are some baobab trees that can go for several years without fruiting or that do not produce fruit at all and such baobabs have been categorized as 'poor producers' (Venter and Witkowski, 2011) or in some areas as 'male' baobabs (Assogbadjo *et al.,* 2009). Farms and nurseries use various seedling and potting media in the production of field transplants, container plants, and greenhouse crops. Such media may contain a wide range of natural and synthetic materials. Soil is very important to man existence for various reasons especially plant growth which man depend entirely for survival. Soil contamination or soil pollution as part of land degradation is caused by the presence of xeno-biotics (human-made) chemicals or other alteration in the natural soil environment Akintola *et al.*, (2019). It is typically caused by industrial activity, agricultural chemicals or improper disposal of waste. Contamination of soil by crude oil and its products has been a widespread environmental problem. Spent engine oil has been known to contain heavy metals which is not only harmful to the soil and human health but to plants, their germination and survival. Oil spills from flow stations, boat fuel spill, oil leakages and deliberate dumping of motor oil or other oil products into the environment lead to slip contamination at large (Fasawe *et al.,* 2021). Disposal of spent lubricant into gutters, water drains, open plots and farms is a common practice especially by motor mechanics in Nigeria which in one way or the other effect soil quality. This Indiscriminate discharge of spent lubricating oil (SLO) is a major source of diffuse or non-point source of oil pollution to the environment. This creates a serious monitoring and control challenge as mechanic workshops and mechanic villages spring up every day and everywhere without plan and policy for management of waste and protection of the environment. The presence of spent lubricant oil in soil increases the bulk density, decreases water holding capacity and aeration propensity (Kayode *et al.,* 2009). Balanites offers ways to help address pressingenvironmental problems such as desertification, andprevention of soil erosion (Mohammed *et al.,* 2023; Gumbo, 2010). This study tried to observe the bioremediation capacity of the boabab in combating the contaminated soil into green productive means by observing the early growth performance of the species at different level of contamination.

MATERIALS AND METHODS

Description of the area of study

This study was conducted in Forest Nursery of the Department of Forestry and Wildlife Management, Federal University Dutse, Jigawa State. University falls between latitudes 11^0 39' to $11^0$69'N and longitude 9^o15' to $9^{0'}$ 36E. The amount of rainfall receives annual is usually around 743 mm. The average annual temperature is 35^0C. The topography is characterized by high land area which is almost 750meters. Soil tends to be fertile ranging from sandy-loam (Salami and Lawal, 2018b).

Materials

The material used for the study comprised of contaminated soil from mechanic garage, uncontaminated soil (top soil), river sand, Seeds of Adansonia, Polythene bags, Nursery tools, meter rule.

Soil collection

Contaminated soil was collected from mechanic garage and top soil was also collected from the school farm while river sand sourced from the Forestry and Wildlife nursery.

Collection of seed

Ripe seeds of the species were collected from the mature mother tree from the forest nursery in the Department of Forestry and Wildlife Management Federal University Dutse, Jigawa State

Experimental design and procedure

The experiment was design to assess the effect of contaminated soil on the early growth performance of *Adansonia digitata* (Baobab) where contaminated soil collected from mechanic garage was mixed with clean soil (top soil) of the Forest Nursery in a ratio of T1 (1:0) contaminated soil only, T2 (1:1) contaminated soil and top soil, T3 (1:2) contaminated soil and top soil, and T4 (0:1) top soil only respectively. In each of the treatments, five (5) pots were filled and stalked in the following design. The seeds of Baobab were placed in water to ascertain the viability of the seeds those that float on the water are regarded as unviable seeds while those that sunk to the bottom are considered as the viable seeds. The viable seeds were soaked in boil distilled water at 100°C for 10 minutes in a 100 ml flask before sowing in the potting mixture (Adeniji *et al.,* 2017; Salami *et al.,* 2019). The experimental set up was watered once daily and germination was monitored till the count germination count was observed and recorded. The treatments were arranged in a Completely Randomized Design with five replications. After two weeks of transplanting from the seed bed to the pots. The early growth study was monitored and recorded every two weeks for the period of twelve weeks. Morphological attributes such as number of leaves which were counted, shoot heights were measured using ruler and collar diameter were measured with the aid of vernier caliper.

Table 1: Showing the arrangements of the treatments in the field

Replicate	T1	T2	T3	T4
R1	T1R1	T2R2	T3R1	T4R1
R2	T1R2	T2R2	T3R2	T4R2
R3	T1R3	T2R3	T3R3	T4R3
R4	T1R4	T2R4	T3R4	T4R4
R5	T1R5	T2R5	T3R5	T4R5

Data analysis

Data collected on the impact of different contamination levels on the growth performance of Baobab seedlings at nursery stage were subjected to Analysis of Variance (ANOVA) using SPSS version 16.00

Results and discussion

The table below is designed to give a clear view of the research work conducted and the findings obtained from first day to last data taken

Table 2: showing the mean of morphological features of the species

Treatment	Shoot height (cm)	Collar diameter (mm)	Leave number
T1	3.52	1.19	63.80
T2	4.36	1.34	94.60
T3	3.36	1.09	99.20
T4	1.76	0.96	40.00

Source: Field survey, (2022)

Results obtained from the field showed in Table 2. T2 had the highest mean shoot height performance (4.36 cm), followed by T1 with the mean value of (3.52 cm) followed by T3 with (3.36 cm). The least performance is T4 with the (1.76 cm) mean respectively. There are significant differences among the treatments at ($p>0.05$) level of significance. Table 2 showed that T2 had the highest diameter with (1.346mm) followed by T1 with (1.19) and T3 with (1.09) respectively. The least performance is T4 with the 0.962mm. There are significant differences among the treatments at ($p>0.05$) level of significance. Table 2 showed that T3, T2 and T1 had the highest leaves number with the mean of 99.2, 94.6 and 63.8 respectively followed by T1 with (40). There are significant differences among the treatments at ($p>0.05$) level of significance.

Table 3: showing the Analysis of variance (ANOVA) for the shoot height of *A. digitata* seedlings

Source of variation	Sum of Squares	Df	Mean Square	F cal	Sig.
Between Groups	17.687	3	5.896	20.017	0.000
Within Groups	4.713	16	0.295		
Total	22.400	19			

Note : the treatment diffrencess is highly significant at ($p>0.05$) level of significance

Table 4: showing the Analysis of variance (ANOVA) for the coller diameter of *A. digitata* seedlings

Source of variation	Sum of Squares	Df	Mean Square	F cal	Sig.
Between Groups	.392	3	.131	5.430	0.009
Within Groups	.385	16	.024		
Total	.777	19			

Note: the treatment differences is significant at ($p>0.05$) level of significance.

Table 5: showing the Analysis of variance (ANOVA) for the leave number of *A. digitata* seedlings

Source of variation	Sum of Squares	Df	Mean Square	F cal	Sig.
Between Groups	11594.000	3	3864.667	60.813	0.000
Within Groups	1016.800	16	63.550		
Total	12610.800	19			

Note : the treatment is significant at (p>0.05) level of significant

DISCUSION

Application of sewage sludge to agricultural land is widely practiced and presumed to be beneficial for plants' growth. However, sewage sludge is often contaminated by heavy metals, organic pollutants, and pathogens (Liphadzi and Kirkham, 2006). This study assessed the ability of *Adansonia digitata* seedlings to accumulate and adapt to the environment. The finding inferred from Table 2 showed that T2 had the highest mean shoot height (4.362cm), followed by T1 with 3.524cm respectively. However, T4 (control) had the least performance with 1.762cm. T2 had the highest mean diameter with 1.35mm followed by T1 with (1.194mm) followed by T3 with (1.09) mean as shown in Table 2 . T3, T2 and T1 had the highest leave production with the mean of 99.2, 94.6 and 63.8 respectively. T4 (control) still had the least leaf counts. There are significant differences among the treatments at 5% probability level for all the morphological characteristics of the species. This study is in agreement with the report of Fasawe (2021) that *Adansonia digitata* can germinate, grow and survive in spent engine oil polluted soils or over used engine oil Akintola *et al.*, (2019) also agreed that there is significant reduction observed in concentrations of heavy metals in the soils before and after planting indicated their enrichment in the plant tissues. It was also reported by Olajuyigbe *et al*., (2019) that Terminalia ivorensis and Hildergardia barteri can grown and survive in spent engine oil. However, Olajuyigbe and Akande (2023) supported the study which showed that control treatment had the highest seedling height and collar diameter, indicating that height increase was inversely related to the increase in spent engine oil concentration. In addition, spent engine oil contamination had a negative influence on leaf production. Furthermore, Jibo *et al*., concurred that the mixture poultry manure, rivers and and topsoil can improve the soil quality for the production of the *Eucalyptus camaldulensis* in the nursery for plantation purposes.

CONCLUSION AND RECOMMENDATIONS

This study showed that *Adansonia digitata* can grow and survive in spent engine oil or over used engine oil. Finding revealed that the species respond well for all morphological features and perform better in both contaminated and top soil. This study therefore, recommended that *Adansonia digitata* can be planted at mechanic garages or avenue planting for cleaning the soil pollution and environment. Further research can be intensified for improvement of the species in terms of economics and ecological benefits it possess.

REFERENCES

Adeniji, I.T., Adeniji, A.M., Wahab, T. Wand Oyebola, M. T. (2017). Evaluation ofdifferent pre-treatment techniques forbreaking seed dormancy in *Acaciaauriculifomis* (Arcunm EX BENTH).Proceedings of the 39th Annual Conferenceof Forestry Association of Nigeria held inIbadan, Oyo State 20- 24 February, 2017.

Akintola, OO; Aderounmu, AF; Abiola, IO; Bodede, I. A (2019). Remediation potential of Baobab (Adansonia digitata L.) Seedlings grown in sewage sludge contaminated by Heavy Metals J. Appl. Sci. Environ. Manage. Vol. 23 (9) 1691-1697 September 2019

Assogbadjo, A.E., Sinsin, B., Codjia, J. T.C., and Van Damme, P. (2005). Ecological diversity and pulp,seed and kernel production of the baobab (*Adansoniadigitata*) in Benin. *Belgian Journal of Botany, 138:*(1) 47-56

Buchmann, C., Prehsler, S., Hartl, A. and Vogl, C. R. (2010): The importance of baobab (*Adansonia digitata L.*) in rural West African subsistence- suggestion of a cautionary approach to international market export of baobab fruits. *Ecology of Food and Nutrition, 49*(3):145-172.

Clayton, M. (2012) Adansonia digitata distribution, structure, abundance and elephant damage across Gonarezhou National Park, southeast Zimbabwe. A thesis submitted in partial fulfilment of the requirements for the degree of Master of Science Department of Biological Sciences Faculty of Science University of Zimbabwe

Dhillion, S.S., and Gustad, C. (2004). Local management practices influence the viability of the baobab (*Adansonia digitata* Linn) in different land use types, Cinzana, Mali. Agriculture Ecosystems and Environment, 101(7):85-103.

Diop, A. G, Sakho, M., Dornier, M., Cisse, M., and Reynes, M. (2006). African baobab (*Adansonia digitata* L.): Principal Characteristics and Utilisation. *Fruits, 61*, 55-69.

Döring, M (2022). English Wikipedia - Species Pages. Wikimedia Foundation. Checklist dataset https://doi.org/10.15468/c3kkgh accessed via GBIF.org on 2023-03-08.

Douie, C and Whittaker, J and Isla Grundy (2015) Verifying the presence of the newly discovered African baobab, *Adansonia kilima*, in Zimbabwethrough morphological *analysis South African Journal of Botany* 100

Emmy D. C., Katerina H. and Patrick V (2010) Baobab (Adansonia digitata L.): A Review of Traditional Uses, Phytochemistry and Pharmacology ACS Symposium Series 23(1)

Fasawe, A. O, Ukamyirioha Chidiebere J , Yakubu Christiana K , Shoyemi Aduratola O, Atsen Esther O , Erhabor Theophilus A* (2021) Comparative Effects of Contaminated Soil Media on the Early Growth of Adansonia digitata Seedlings South Asian Research *Journal of Agriculture and Fisheries*; Vol-3, Iss-4 (July-Aug, 2021): 57-60

Gumbo, E.N.C. (2010). The Dry Forests and Woodlands of AfricaManaging for Products and Services (E. N. C. and D. J. Gumbo (ed.). Earthscan.

Jen, G., Yahia O and Aida, C. S (2016) Africa's wooden elephant: the baobab tree (*Adansonia digitata* L.) in Sudan and Kenya: a review Genetic Resources and Crop Evolution 63(3):377-399 springer

Jibo, A. U., Salami K. D, Lawal A. A, Muhammad Y. K, (2021): Influence of Soil Amendments on the Growth Performance of *Eucalyptus Camaldulensis* (Dehnh) Seedlings *J. For. Sci. Env. Vol. 6 (2021): 8 – 13* ISSN 2635-3296

Kayode J. O., Olowoyo., and Oyedeji, A. (2009). The effects of used engine oil pollution on the growth and early seedling performance of *Vigna uniguiculata* and Zea mays. Res. J. Soil Biol., 1; 15-19.

Liphadzi, MS; Kirkham, MB (2006). Heavy metal displacement in chelate-treated soil with sludge during phytoremediation. *J. Plant Nutr. Soil Sci*. 169,737–744.

Mohammed I. N, Ali B, Rabiu S, and Mustapha, A.U (2023). Exploring the Silviculture and Silvics of Desert Date (Balanites aegyptiaca) in Northern Nigeria: Opportunities for Economic, Social and Environmental Development. *Direct Research Journal of Agriculture and Food Science* https://www.researchgate.net/publication/369023362_Exploring_the_Silviculture_and_Silvics_of_Desert_Date_Balanites_aegyptiaca_in_Northern_Nigeria_Opportunities_for_Economic_Social_and_Environmental_Development [accessed Mar 08 2023].

Olajuyigbe, S. O. and Akande, V. O. (2023) Phytoremediation of Spent Engine Oil Contaminated Soil using *Eucalyptus camadulensis* (Dehnh) Seedlings. Sustainable Production and Consumption Of Forest Products**.** Proceedings of the 1st International Conference the International Society of Tropical Foresters, Nigeria Chapter Held in Ibadan, Oyo State, Nigeria 14th – 16th February 2023

Olajuyigbe, S. O., Fayinminnu, O. O. and Ayoade, A. O. (2019). Phytoremediation of diesel and spent engine oil contaminated soil using Kariya (Hildergardia barteri Mast.) seedlings. *Nigerian Journal of Biotechnology* 36: 139 –149

Pettigrew, RFS, J. D., Bell, K. L., Bhagwandin, A., Grinan, E., Jillani, N., Meyer, J., Wabuyele, E., and Vickers, C. E. (2012). Morphology, ploidy and molecular phylogenetics reveal a new diploid species fromAfrica in the baobab genus*Adansonia*(Malvaceae: Bombacoideae). *Taxon, 61* (6):1240- 1250.

Salami, K. D and Lawal, A. A (2018b). Tree species Diversity and Composition in the Orchard of Federal University Dutse, Jigawa State. *Journal of Forestry Research and Managemen*t. ISSN 0189-8418, www.jfrm.org.ng ,Vol 15(2):112-122

Salami, K. D. and Lawal, A. A. (2018a). Description of Economical Trees and Shrubs species in Northern part of Nigeria and their potentials. A proceeding of the 6th Biennial National Conference of the Forests and Forest Products Society. April 23th-27th, 2016, Pp136-144.

Salami, K. D., Jibo, A. U., Lawal, A. A. Ahmad, U. and Harisu, S. (2021). Assessment of Pre-Sowing Treatments on the Seed Germination of Adansonia Digitata Linn (Baobab) in the Savannah Region of Nigeria. A proceeding of the 7th Biennial Conference of the Forest Production and Products in a Diversifying Economy for Sustainable Livelihood. April 26th-30th , 2021, Pp 226-271

Salami, K. D., Odewale, M. A., Gidado, A. H and Adam, Z. A (2019): Pre-germination Treatments on Seeds of *Balanites aegyptiaca* (L) Delile and Influence of Potting Mixtures on the Early Growth. *Journal of Forestry Research and Management.* Vol. 16(1).107-117; 2019, ISSN 0189-8418. www.Jfrm.org.ng IBADAN

Sidibe, M and Williams, JT (2002). Baobab – *Adansonia digitata*. Fruits for the future. Int. Centre Underutil. Crops, Southampton, UK, 96 p.

Venter, S. M., and Witkowski, E. T. F. (2011): Baobab (*Adansonia digitata* L.) fruit production in communal and conservation land-use types in SouthernAfrica. *Forest Ecology and Management, 261,* 630-639.

Wickens, G. E., and Lowe, P. (2008). The Baobabs: Pachycauls of Africa, Madagascar and *Australia. London, UK: Springer 630-639*